Claims

1. A microcapsule comprising
a solidified hydrophobic shell matrix,
an encapsulated aqueous bead or beads which is/are further encapsulated in or by the solidified hydrophobic shell matrix, and
an active ingredient or active ingredients dissolved or incorporated in the encapsulated aqueous bead or beads.

2. A microcapsule according to claim 1, characterised in that the encapsulated aqueous bead is an aqueous hydrocolloid bead.

3. A microcapsule according to claim 1 or 2, characterised in that the encapsulated hydrocolloid bead is a gelled or cross-linked hydrocolloid bead.

4. A microcapsule according to claim 1 or 2, characterised in that the encapsulated aqueous bead is encapsulated by coacervation using a suitable encapsulating material.

5. A microcapsule according to claim 4, characterised in that the encapsulating material used in coacervation is selected from the group comprising shellac, zein, any synthetic or natural hydrophobic polymers, fats, emulsifiers, waxes, any mixture of oppositely charged hydrocolloids, such as gelatine/arabic gum, gelatine/CMC, any proteins/ionic hydrocolloids, any combination of hydrocolloids and a solubility-reducing agent such as salts, sugars, acids or bases, or sucrose acetate isobutyrate (SAIB), dammar gum and glyceryl esters of wood rosin or mixtures thereof.

6. A microcapsule according to claim 1 or 2 characterised in that the encapsulated aqueous bead is encapsulated by sintering using a suitable encapsulating material.

7. A microcapsule according to claim 6, characterised in that the encapsulating material used in sintering is selected from the group comprising any water-insoluble microparticles, such as silicone dioxide, titanium dioxide, synthetic or natural food-grade polymer beads or any water-insoluble solid particles.

8. A microcapsule according to any one of claims 1 to 3, characterised in that the encapsulated aqueous bead comprises any food-grade hydrocolloid which has a gelling

temperature above storage temperature.

9. A microcapsule according to any one of claims 1 to 3, characterised in that the encapsulated aqueous bead comprises any food-grade hydrocolloid which can be cross-linked.

10. A microcapsule according to any one of claims 8 or 9, characterised in that the hydrocolloid is selected from the group comprising sodium alginate, arabic gum, gellan gum, starch, modified starch, guar gum, pectin, amidified pectin, carrageenan, gelatine, chitosan, mesquite gum, agar gum, hyaluronic acid, whey protein, soy protein, sodium caseinate, xanthan/locust bean gum mixture, cellulose derivatives such as cellulose acetate phtalate, hydroxy propyl methylcellulose (HPMC), methyl cellulose, ethyl cellulose and carboxy methyl cellulose (CMC), methyl acrylic copolymers, such as Eudragit®, psyllium, tamarind, xanthan, locust bean gum, whey protein, soy protein, sodium caseinate, shellac, zein, any synthetic or natural water-soluble polymers, any food-grade protein, and mixtures thereof.

11. A microcapsule according to any one of the preceding claims, characterised in that the hydrophobic shell matrix is selected from the group comprising animal oils and fats, fully hydrogenated vegetable or animal oils, partially hydrogenated vegetable or animal oils, unsaturated, hydrogenated or fully hydrogenated fatty acids, unsaturated, partially hydrogenated or fully hydrogenated fatty acid monoglycerides and diglycerides, unsaturated, partially hydrogenated or fully hydrogenated esterified fatty acids of monoglycerides or diglycerides, unsaturated, partially hydrogenated or fully hydrogenated free fatty acids, other emulsifiers, animal waxes, vegetable waxes, mineral waxes, synthetic waxes, natural and synthetic resins, and mixtures thereof.

12. A microcapsule according to any one of the preceding claims, characterised in that the active ingredient is selected from the group comprising flavours, flavour enhancers, nutrients, vitamins, preservatives, leavening agents, micro organisms, acidulants, antioxidants, colours, enzymes, gases, thickeners and any other food or pharmaceutical ingredients, such as antibiotics, antimicrobials, anti-inflammatory agents, analgesics, sedatives, hypnotics, anxiolytic agents, antihistamines, antiarrhythmics, antihypertensive agents, antiparkinson agents and hormones.

13. A microcapsule according to any one of the preceding claims, characterised in that

one microcapsule comprises approximately 1 to 100 aqueous beads embedded in the hydrophobic shell matrix, preferably 5 to 50 aqueous beads.

14. A method for preparing microcapsules, comprising the steps of

a) providing an aqueous phase and an active ingredient or active ingredients dissolved or incorporated in the aqueous phase,

b) providing a hydrophobic phase in melted form,

c) incorporating or dissolving an encapsulating material or a mixture of encapsulating materials in the aqueous phase or in the hydrophobic phase,

d) combining the aqueous phase with the hydrophobic phase and homogenizing or mixing the combined phases to form a water-in-oil emulsion,

e) encapsulating the aqueous phase in the emulsion, whereby a dispersion comprising encapsulated aqueous beads is formed and the active ingredient or active ingredients are encapsulated in the aqueous beads, and

f) processing the dispersion obtained in step e) to form microcapsules where the encapsulated aqueous beads are further encapsulated in or by the solidified hydrophobic shell matrix.

15. A method according to claim 14, characterised in that the aqueous phase is selected from the group comprising water or a mixture of water and any other water-miscible solvents, such as ethanol, ethylene glycol, glycerol.

16. A method according to claim 14 or 15, characterised in that the encapsulating material is selected from the group comprising hydrocolloids, sodium alginate, gum arabic, gellan gum, starch, modified starch, guar gum, agar gum, pectin, amidified pectin, carrageenan, xanthan, gelatine, chitosan, mesquite gum, hyaluronic acid, cellulose derivatives such as cellulose acetate phtalate, hydroxy propyl methylcellulose (HPMC), methyl cellulose, ethyl cellulose and carboxy methyl cellulose (CMC), methyl acrylic copolymers, such as Eudragit®, psyllium, tamarind, xanthan, locust bean gum, whey protein, soy protein, sodium caseinate, any food-grade protein, shellac, zein, any synthetic or natural water-soluble polymers, any water-insoluble microparticles, such as silicone dioxide, titanium dioxide, synthetic or natural food-grade polymer beads or any water-insoluble solid particles susceptible to sintering.

17. A method according to any one of claims 14 to 16, characterised in that the hydrophobic phase is selected from the group comprising animal oils and fats, fully

hydrogenated vegetable or animal oils, partially hydrogenated vegetable or animal oils, unsaturated, hydrogenated or fully hydrogenated fatty acids, unsaturated, partially hydrogenated or fully hydrogenated fatty acid monoglycerides and diglycerides, unsaturated, partially hydrogenated or fully hydrogenated esterified fatty acids of monoglycerides or diglycerides, unsaturated, partially hydrogenated or fully hydrogenated free fatty acids, other emulsifiers, animal waxes, vegetable waxes, mineral waxes, synthetic waxes, natural and synthetic resins, and mixtures thereof.

18. A method according to any one of claims 14 to 17, characterised in that the combining of the aqueous phase with the hydrophobic phase is performed by mixing.

19. A method according to any one of claims 14 to 18, characterised in that the homogenisation in step d) is performed by high-shear mixing or by in-line mixing.

20. A method according to any one of claims 14 to 19, characterised in that the encapsulating is performed by gelling, cross-linking, coacervation or by sintering.

21. A method according to claim 20, characterised in that encapsulating by coacervation is performed by using an encapsulating material and reducing the solubility of the encapsulating material.

22. A method according to claim 21, characterised in that the solubility of the encapsulating material is reduced by changing the temperature, by changing the pH, by adding additives or by adding hydrocolloids or any suitable coacervation-inducing agent.

23. A method according to claim 21 or 22 characterised in that the encapsulating material is selected from the group comprising shellac, zein, any synthetic or natural hydrophobic polymers, as well as fats, emulsifiers, waxes or mixture thereof.

24. A method according to claim 20, characterised in that encapsulating by sintering is performed by using solid microparticles as an encapsulating material.

25. A method according to claim 24 characterised in that the microparticles are fused into a continuous film around the aqueous phase by subjecting the microparticles to temperatures above their sintering or glass transition temperatures.

26. A method according to claim 24 or 25 characterised in that the encapsulating material is selected from the group comprising any water-insoluble microparticles, such as silicone dioxide, titanium dioxide, synthetic or natural food-grade polymer beads or any water-insoluble solid particles.

27. A method according to claim 20, characterised in that the encapsulating of the aqueous phase is performed by gelling and the gelling of the aqueous phase in the emulsion is performed by lowering the temperature of the emulsion below the gelling temperature of the encapsulating material.

28. A method according to claim 27 characterised in that the encapsulating material is selected from the group comprising gelling hydrocolloids, such as carrageenan, gelatine, starch, modified starch, agar gum, guar gum and mixture of xanthan and locust bean gum or mixture of any gelling hydrocolloids.

29. A method according to claim 20, characterised in that the encapsulating of the aqueous phase is performed by cross-linking by using an encapsulating material selected from the group comprising any food-grade proteins such as soy protein, whey proteins, caseinate gelatine, or starch, modified starch, chitosan, cellulose derivatives such as cellulose acetate phtalate, hydroxy propyl methyl cellulose (HPMC), methyl cellulose, ethyl cellulose and carboxy methyl cellulose (CMC), methyl acrylic copolymers, such as Eudragit, any synthetic or natural water-soluble polymers, susceptible to cross-linking by heat, pH or chemical treatment and mixture thereof.

30. A method according to claim 29 characterised in that the cross-linking is performed by heating, applying pressure or by enzymatic cross-linking.

31. A method according to any one of claims 14 to 30, characterised in that the processing in step f) is performed by spray cooling.

32. A method according to any one of claims 14 to 30, characterised in that the processing in step f) is performed by fluidised bed cooling.

33. A method according to any one of claims 14 to 32, characterised in that the active ingredient is selected from the group comprising flavours, flavour enhancers, nutrients, vitamins, preservatives, leavening agents, micro organisms, acidulants, antioxidants,

colours, enzymes, gases, thickeners and any other food or pharmaceutical ingredients.

34. A method according to any one of claims 14 to 33, characterised in that one microcapsule comprises approximately 1 to 100 aqueous beads embedded in the hydrophobic shell matrix

35. A method according to claim 34, characterised in that one microcapsule comprises 5 to 50 aqueous beads embedded in the hydrophobic shell matrix.

36. A microcapsule obtained or obtainable by a method as defined in any one of claims 14 to 35.

37. Use of a microcapsule as described in any one of claims 1 to 13 or 36 as an additives in food industry.

38. Use of a microcapsule as described in any one of claims 1 to 13 or 36 as a flavour agent, a preservative agent or a bacteriocin agent.

39. Use of a microcapsule as described in any one of claims 1 to 13 or 36 in a pharmaceutical application.

40. Use of the microcapsules according to claim 39 in depot-tablets or trans-dermal application systems.